NETWORKS AND MISSION SERVICES PROJECT

WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) Operations Concept

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1.0 Introduction

1.1 Purpose and Scope

The White Sands Complex (WSC) Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) supports customers who require TCP/IP access to the WSC for telemetry and command processing. Support is provided from the NASA Integrated Services Network (NISN) Closed IP Operational Network (IONET), using a defined set of authorized addresses. Support provided by the first version of the WDISC is approved for three initial customers, New Millennium Program Earth Orbiter-1 (NMP/EO-1), Gravity Probe B (GP-B), and Far Ultraviolet Spectroscopy Explorer (FUSE). However, a fourth customer, Microwave Anisotropy Probe (MAP), will also be using WDISC services.

1.2 Objectives

The WDISC is intended to provide a common solution to the needs of TCP/IP customers. No mission unique equipment at WSC should be needed to provide these data services. The design should allow for enhancements in capabilities and capacity. In particular, the WDISC should be able to evolve as new standards, such as the Consultative Committee for Space Data Systems (CCSDS) Space Link Extension (SLE) services, are adopted.

1.3 Background and Context

The WSC currently processes telemetry and command streams using legacy interfaces based on Nascom 4800 bit block formats. The WSC operates at the bit level and provides data quality monitoring at the frame level. Higher level formats and protocols (such as CCSDS packet telemetry or telecommand) are passed along to the customer unchanged for all further higher-level processing.

In addition to providing TCP/IP access to WSC, the WDISC also handles some higher-level activities such as Reed-Solomon decoding of return service data (i.e., telemetry).

1.4 Overview

The remainder of this document is organized as follows. Section 2 considers policy issues, Section 3 defines the structure and function of the WDISC, and Section 4 describes the principal operations of the WDISC. Appendix A provides a set of high-level procedures for obtaining WDISC services.

1.5 References

The latest version of the following documents is applicable.

a. WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) Project Management Plan (PMP), 451-WDISC-PMP 98.

- b. WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) System Requirements, 451-WDISC-SRD 98.
- c. WSC Transmission Control Protocol (TCP)/Internet Protocol (IP) Data Interface Service Capability (WDISC) Service Specification, 451-WDISC-SSD 98.
- d. Detailed Mission Requirements (DMR) Document for the Gravity Probe-B Mission (GP-B), 450-215/GP-B.
- e. Detailed Mission Requirements (DMR) Document for the New Millennium Program Earth Orbiter-1 (NMP/EO-1), 450-215/EO-1.
- f. Space Network (SN) Detailed Mission Requirements for the Far Ultraviolet Spectroscopic Explorer (FUSE), No Identifier.
- g. EO-1 Spacecraft to Ground Interface Control Document, No Identifier.
- h. Requirements Specification for the White Sands Complex (WSC), 530-RSD-WSC.
- i. Space Network (SN) User's Guide, 530-SNUG.
- j. Programmable Telemetry Processor for Windows NT (PTP-NT), User's Manual, No Identifier.
- k. NASA Communications (Nascom) Programmable Telemetry Processor (PTP) Installation and Troubleshooting Guide, No Identifier.
- 1. Interface Control Document (ICD) Between the Network Control Center (NCC)/Flight Dynamics Facility (FDF) and the White Sands Complex (WSC), 530-ICD-NCC-FDF/WSC.

2.0 Management Policy

2.1 Constraints

The WDISC interfaces with WSC and the Network Control Center (NCC), as well as with the customer. The WDISC operates within the Data Interface System (DIS) element of the WSC and is controlled and configured by the NCC. It requires minimal interaction with operational personnel.

NOTE

The initial delivery of the WDISC will be compatible with the workstations used in NCC 98 (i.e., Hewlett Packard UNIX boxes) but is independent of NCC 98. Any integration, acceptance testing, or mission testing using the WDISC prior to official operations using NCC 98 will be conducted using equipment provided by the NCC Test and Training (T&T) or Operational Evaluation Testing (OET) facilities.

2.2 Risks

Use of commercial off-the-shelf (COTS) software with minimal custom development should limit the risks associated with the development of the WDISC. Operational risks are expected to be minimal.

3.0 System Description

3.1 Functional Capabilities

The WDISC supports the following functional capabilities

- a. Receive encapsulated forward service data from a customer Mission Operations Center (MOC) via the Closed IONET, convert data to serial form, and present it a WSC local interface (LI) port.
- b. Receive serial return service data from a WSC LI port, encapsulate it, and transmit it to a customer MOC via the Closed IONET.
- c. Data monitoring including computing CCSDS statistics for forward and return data processed.
- d. Data recording.
- e. Data playback.
- f. Provide real-time status on forward and return service data processed for use at the NCC and/or WSC.

3.2 Reference Architecture

The reference architecture is shown in Figure 3-1, which has been adapted from Reference a. It consists of the Closed IONET, PTPs, and the MOC. The WDISC comprises four PTP units, two (primary and backup) located in each of the WSC ground terminals—WSGT and STGT. Each PTP has three processing "boards." Each board can handle a single forward and a single return data stream for the same customer, and any board can be used to fully support any of the initial customers. This provides additional redundancy. Appropriate switching and controls permit failover to occur between matching boards on the prime and backup PTP units.

NOTE

Two boards would be required to support dual data source customers (i.e., independent I and Q return data streams).

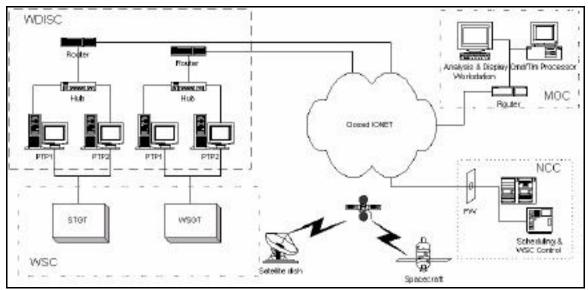


Figure 3-1 WDISC Reference Architecture

3.3 System Interfaces

3.3.1 Data Interfaces

The WDISC has the following data interfaces

- a. TCP/IP interfaces with the customer for transport of forward and return data.
- b. Serial interfaces with the LI port.
- c. TCP/IP interfaces with the customer via File Transfer Protocol (FTP) for playback data.

3.3.2 Control Interfaces

The WDISC has the following control interfaces

- a. TCP/IP interfaces with the NCC operator via a graphical user interface (GUI) for schedule entry.
- b. TCP/IP interfaces with the NCC operator via COTS GUI for status reporting.
- c. TCP/IP interfaces with the customer via socket-level transport for controlling configuration of forward data flows.
- d. TCP/IP interfaces with the customer for reporting status of forward services (i.e., system heartbeat)
- e. TCP/IP interfaces with the NCC operator via COTS GUI for controlling the configuration of forward data flows.

f. TCP/IP interfaces with the WSC operator via COTS GUI for status reporting, maintenance of configuration files, and controlling the configuration of forward data flows.

3.4 Future System Extensions

A proposed enhanced version of the WDISC is planned to interface automatically with NCC systems to receive scheduling information and to provide status information. This would eliminate the need for routine NCC operator activity to support WDISC capabilities. At this time two options are under consideration.

- a. A near-term implementation would extract data from the NCC's Service Planning Segment Replacement (SPSR) data base and load it on the PTP automatically under NCC operator supervision.
- b. A long-term option would be to fully integrate WDISC control as an autonomous module into an enhanced version of NCC 98.

4.0 System Operation

4.1 Operational Requirements

The WDISC is capable of being remotely operated by NCC personnel. Operation by WSC personnel is also possible if necessary. Limited operator actions are needed for nominal operation.

- a. Daily review of the NCC schedule and subsequent (manual) entry of "PTP schedules" based on information contained in the NCC schedule.
- b. Initial entry of "desktop" files, which define the nominal configurations of the PTP required by each customer.
- c. Occasional maintenance of "desktop" files.
- d. Failover activities if a failure condition occurs.
- e. Maintenance of hardware and software configuration of the PTP.

4.2 Operational Scenarios

4.2.1 Daily Schedule Upload to the PTPs

The MOC requests SN services by submitting standard Schedule Add Request (SAR) messages to the NCC. As appropriate, the NCC Scheduler may instead enter SARs based on voice, fax, or email input from the MOC. The WSC provides its support based on the scheduling orders (SHOs) sent from the NCC. The only scheduling information provided to the PTP is that needed to correctly process and transport data between the MOC and the LI at WSC.

The NCC Scheduler consults the daily schedule to identify each event that requires WDISC support. Using a GUI that runs on the NCC 98 workstation—the PTP timer client—the operator completes one or more entry forms. For each event, the operator enters the SIC, start and stop times, the scheduled ground terminal, and a configuration identifier based on the UIFC that specifies the PTP "desktop" needed for that event. The forms are transmitted to a PTP at WSC and addressed to the PTP timer server (i.e., software process) that is associated with the specified board. The information is stored there and used to set up, start, and stop the PTP as specified. Feedback is provided to permit the NCC operator to document the results of the schedule upload. To support the prime and backup PTPs, this information is sent separately by the GUI to both PTPs at the appropriate ground terminal.

Each PTP board is connected to a specific forward LI port and a specific return LI port as identified by the UIFC. A distinct "desktop" is associated with each board. The GUI assists the operator in selecting the correct "desktops" and facilitates the process of scheduling the prime and backup PTPs at the appropriate ground terminal.

4.2.2 Initial Loading of PTP Configuration Information

The PTP "desktops" and any other mission-related information are developed and loaded into each PTP prior to its shipment and installation at WSC.

4.2.3 Maintenance of PTP Configuration Information

A PTP configuration maintenance (CM) unit, either a fully configured PTP or a standard Windows NT box, is located in the NCC computer room or other work area. The NCC Data Base Administrator (DBA) or system administrator updates PTP configurations at WSC by logging on from the PTP CM unit. COTS software is used to access and modify the PTP "desktops" and other files. It is assumed that "desktops" defined at the beginning of a customer mission generally require no changes throughout the mission. It will be necessary to update each of the four PTPs individually working from a master version on the CM unit.

NOTE

As new customers come on-line, the developers responsible for initial "desktop" development (see paragraph 4.2.2) will create new "desktops" to meet new requirements. The new desktops will be maintained as stated above. At a later time, responsibility for "desktop" maintenance may transfer to WSC.

4.2.4 Obtaining Real-time Status from the PTPs

The NCC Performance Analyst or other NCC operator may access current status information from the PTP by logging on to the PTP from the Windows NT box located in

the rear of the operations control room (OCR). PTP status will include the number of frames processed, the number of errors, and other statistics.

The WSC operator may also access the same information from a Windows NT box located in the TDRSS Operations Control Center (TOCC). If a failure condition is noted, the TOCC operator may participate in fault isolation and recovery assistance.

4.2.5 PTP Failover

Although redundant PTP equipment is provided, any failovers will be handled manually by the NCC operator, upon notification by the MOC. The PTP acts as a server for this purpose. Appendix A and Reference c provide additional detail. NCC and/or WSC personnel are responsible for correcting the failure (e.g., by rebooting the failed PTP).

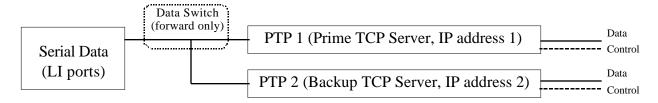


Figure 4-1 Redundancy and Failover

4.2.5.1 Return Data

As shown in Figure 4-1, both PTPs receive return data from the return LI port. The PTPs are configured with the same "desktop." First, the client attempts to connect to PTP 1. If the connection fails or if the client cannot read any data for a specified time-out period, then the client attempts to connect to PTP 2. Appendix A indicates how the MOC might detect and react to a failure while a return service is in progress.

NOTE

The MOC may connect to both PTPs and receive two return data flows if sufficient bandwidth is available.

4.2.5.2 Forward Data

A data switch is provided to switch forward data from either PTP 1 or PTP 2 to the forward LI port. There are three switches at each ground terminal, corresponding to the three boards in PTP1 and PTP2. The MOC connects to the primary PTP via data and control ports and sends a control character string designating the primary PTP (see Figure 4-1). The PTP then configures the data switch based on that control character string. If a failure occurs, the NCC sends new control information to the backup PTP (i.e., the control character string designating the backup PTP). The backup PTP then reconfigures the data switch and the flow of forward data can continue. Appendix A indicates how the MOC might detect and react to a failure while a forward service is in progress.

NOTE

The data switch permits forward data flow either from PTP1 or PTP2, never both. Configuring the switch from the primary PTP enables forward data flow to the primary and disables flow to the backup, and vice versa.

NOTE

In a contingency, the WSC operator may also control the configuration of the forward data switch using the access described in paragraph 4.2.4.

4.2.6 Management of PTP Configuration

4.2.6.1 Hardware Maintenance

The WSC maintenance and operations staff provides any maintenance of the PTP platform as necessary. Failed units will be returned to the vendor for repair. A spare PTP is available during the repair period for redundancy. Diagnostics and loop back capabilities are included in the COTS product.

4.2.6.2 Software and Data Management

Configuration management personnel at WSC update the PTP software releases using existing WSC configuration management procedures. All data configuration management is provided as described in paragraph 4.2.3.

Appendix A Preliminary Procedure for Obtaining Data Services

A.1 Timeframe

In the following procedures, the scheduled service start time is denoted as "T." Acquisition of signal (AOS) and data flow typically begin a few seconds after time T (see Reference i for a better estimate).

A.2 Pre-Service Activities

a. [approximately T − 2 weeks] Customer requests service for each support period within a seven day time span by submitting a separate SAR to the NCC or by providing other input by voice, fax, or email. For each service to be provided, the SAR references a Service Specification Code (SSC) maintained in the NCC database. The SSC contains the detailed information necessary to schedule and configure a SN service. This includes a complete list of UIFCs valid for the service. Within the NCC database, each UIFC is mapped to either a WSGT or STGT LI port.

NOTE

The support period corresponds to a single event on a specific TDRS providing one or more services. The procedures used to request these events are beyond the scope of this document (i.e., limited to PTP actions). Reference i provides a full description of this process.

- b. [approximately T 1 week] Customer receives confirmation for each scheduled event via a USM or other notification. Notification indicates which UIFC is scheduled for each data channel. Distinct UIFCs will be used for each ground terminal. The customer can then identify the correct domain name (i.e., IP address) for the prime and backup PTP at the scheduled ground terminal.
- c. No planning activities may be possible in a contingency or emergency situation. All PTP support will be coordinated in real time.

A.3 Return Service

- a. [T-5 second] Customer opens a TCP/IP connection (socket) on the prime PTP using the mission-specific data port assigned to that customer and (optionally) a connection on the backup PTP using the same data port. The PTP board is fully configured and operational at this time.
- b. [AOS through end of support period] Customer receives telemetry under CCSDS protocols. The presence of telemetry confirms the proper functioning of the return service. The connection remains active for three seconds after the service stop time to deliver the final frames of data.

c. [post event] When playback is required, customer determines the file identifier and downloads the recorded data file from the FTP server located on the PTP used to capture the data.

NOTE

Playback does not require the use of "desktops" and need not be scheduled.

NOTE

Customers that access the WDISC via the Closed IONET may carry out the download autonomously. Security policy requires that customers who access the WDISC via the Open IONET contact the NCC PA and request a download. The NCC Operator will then download the requested files directly to the customer's facility.

- d. [contingency: fault with the prime PTP] Customer fails to receive return data from the prime PTP. Customer informs the NCC operator via voice for assistance in fault isolation. The WSC operator also participates in this activity.
 - 1. Customer connects to backup PTP if not already connected (see step a).
 - 2. Customer receives telemetry from backup PTP (see step c).

A.4 Forward Service

- a. [T 5 seconds] Customer opens a TCP/IP connection (socket) on the prime PTP using the mission-specific data port assigned to that customer and (optionally) a TCP/IP connection on the backup PTP using the same data port.
- b. [T 5 seconds] Customer opens a TCP/IP connection (socket) on the prime PTP using the mission-specific control port assigned to that customer and (optionally) a TCP/IP connection on the backup PTP using the same control port.
- c. [T-5] seconds or later Customer configures the forward data switch by transmitting to the control port via a socket connection the control character string designated for the prime PTP.
- d. [AOS through end of support period] Customer waits a delay period to permit an idle pattern to be established, as required by CCSDS or other specifications. Customer transmits command data as needed.
- e. [AOS through end of support period] Customer accesses the control port for the selected PTP board on the prime PTP and receives status (i.e., system heartbeat) confirming that the PTP is actively providing forward service.

- f. [contingency: fault with the prime PTP] Customer fails to receive system heartbeat and cannot transmit forward data using the prime PTP. Customer informs the NCC operator via voice for assistance in fault isolation. The WSC operator also participates in this activity.
 - 1. Customer connects to the data port on the backup PTP if not already connected (see step a).
 - 2. Customer connects to the control port on the backup PTP if not already connected (see step b).
 - 3. NCC operator configures the forward data switch by transmitting on the control port on the backup PTP a control character string designated for the backup PTP.
 - 4. Customer receives service from the backup PTP (see step c).
 - 5. Customer waits the required delay time to permit the idle pattern to be established. Customer transmits command data as needed (see step d).

Abbreviations and Acronyms

AOS acquisition of signal

CCSDS Consultative Committee for Space Data Systems

CM configuration management
COTS commercial off-the-shelf
DBA Data Base Administrator
DIS Data Interface System

EO-1 Earth Orbiter-1

FTP File Transfer Protocol

FUSE Far Ultraviolet Spectroscopy Explorer

GP-B Gravity Probe B

GUI graphical user interface IONET IP Operational Network

IP Internet Protocol
LI local interface

MAP Microwave Anisotropy Probe MOC Mission Operations Center

NASA National Aeronautics and Space Administration

NCC Network Control Center

NISN NASA Integrated Services Network

NMP New Millennium Program OCR Operations Control Room

OET Operational Evaluation Testing
PTP Programmable Telemetry Processor

SAR schedule add request SHO scheduling order

SIC support identification code

SLE space link extension SN Space Network

SPSR Service Planning Segment Replacement STGT Second TDRSS Ground Terminal

T&T Test and Training

TCP Transmission Control Protocol

TDRSS Tracking and Data Relay Satellite System

TOCC TDRSS Operations Control Center

UIFC user interface channel ID

WDISC WSC TCP/IP Data Interface Service Capability

WSC White Sands Complex

WSGT White Sands Ground Terminal